WAKE FOREST UNIVERSITY	**Standard Operating Procedure (SOP)**	

COMPRESSED GASSES AND CRYOGENIC FLUIDS

Effective Date:	**8/23/2013**	**Revised Date:**	**10/10/2022**

Introduction

- This SOP applies to COMPRESSED GASSES AND CRYOGENIC FLUIDS.
- COMPRESSED GAS is defined as a gas or mixture of gasses having an absolute pressure exceeding 40 psi at 70 degrees F (21.1 degrees C); or, a gas or mixture of gasses having an absolute pressure exceeding 104 psi at 130 degrees F (54.4 degrees C) regardless of the pressure at 70 degrees F; or, a liquid having a vapor pressure exceeding 40 psi at 100 degrees F (37.8 degrees C) as determined by ASTM D-323-72.
- COMPRESSED GASSES may be categorized as follows:
    1. **Asphyxiant gas**: A gas, usually inert, that may cause suffocation by displacing the oxygen in the air necessary to sustain life, or is labeled by the DOT as Division 2.2.
    2. **Corrosive gas:** A gas that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact or is labeled by the DOT as Division 2.3 and Division 8 (Corrosive).
    3. **Cryogenic fluid:** A refrigerated liquefied gas having a boiling point colder than -90 °C (130 °F) at 14.7 psia absolute, or which the DOT requires the Division 2.2 label for non-flammable, nonpoisonous compressed gas-including compressed gas, liquefied gas, pressurized cryogenic gas, compressed gas in solution, asphyxiant gas and oxidizing gas.
    4. **Flammable gas:** A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or, a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit; or, one for which the United States Department of Transportation (DOT) requires the red flammable gas label or is labeled as Division 2.1.
    5. **Oxidizer gas:** A gas that is nonflammable but can support and vigorously accelerate combustion in the presence of an ignition source and a fuel or is labeled by DOT as Division 2.2 and Division 5.1 (Oxidizer).
    6. **Toxic gas:** A gas that has a median lethal concentration (LC_{50}) in air of 2,000 parts per million or less by volume of gas (Highly Toxic has an LC_{50} of 200 ppm or less); or, a gas which the DOT requires the white poison label or is labeled as Division 2.3 “Gas poisonous by inhalation” because it is known to be so toxic to humans as to pose a hazard to health during transportation; or a gas that has an NFPA Health Hazard Rating of 3 (Toxic) or 4 (Highly Toxic).

(SOURCE: Stony Brook University Compressed gas and Cryogenic Fluid Handling, Storage, Disposal, 1993)

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POTENTIAL HAZARDS

- ➢ The high pressure of compressed gasses constitutes a serious potential hazard in the event of containment rupture or unregulated release.
- ➢ Additional hazards from compressed gasses are posed from the physical and health hazards associated with the properties of the gas.

HEALTH HAZARDS

- ➢ Asphyxiation.
- ➢ See SAFETY DATA SHEET for additional health hazards for specific gas.

PERSONAL PROTECTIVE EQUIPMENT

EYE PROTECTION

- Safety glasses, goggles or face shields shall be worn during operations in which COMPRESSED GASSES might contact the eyes (e.g., through vapors or splashes of solution).
- Ordinary (street) prescription glasses do not provide adequate protection. Adequate safety glasses must meet the requirements of the Practice for Occupational Education Eye and Face Protection (ANSI Z87.1-1989) and must be equipped with side shields.

HAND PROTECTION

- Use disposable nitrile gloves when working with chemicals. Check chemical compatibility chart for breakthrough time when using
- Laboratory personnel should thoroughly wash hands with soap and water before and immediately upon removal of gloves.

LAB COATS, ETC.

- Button lab coats, closed toed shoes, long pants and long sleeved clothing shall be worn when handling COMPRESSED GASSES. Protective clothing shall be worn to prevent any possibility of skin contact with COMPRESSED GASSES.

GENERAL WORK PRACTICES

- ➢ Identifying labels must be kept in place on cylinders.
- ➢ Do not use inappropriate hose material as dispensing tubes from gas cylinder regulators. Corrosive gasses may destroy rubber or latex tubing. Tygon tubing should perhaps be used instead, or copper or stainless steel.
- ➢ Corroded cylinder valve stems, gas line fittings, or regulators are a source of danger and should be exchanged for better quality equipment.
- ➢ Take the regulator off the cylinder before moving. Move the cylinder on a two-wheeled chain cylinder dolly or similar device made specifically for cylinders. Chain the cylinder and push the cart slowly. Never move a cylinder without a threaded valve cap cover attached.

- Never leave cylinders unstrapped in the lab. Secure them against a wall or a lab bench.
- Keep track of where you store cylinder caps for cylinders being in use.
- Do not grease or oil the regulator thread of a cylinder valve. Oil on a gas cylinder thread will soon be under very high pressure. If the gas reacts at all with organic material, this could lead to an explosion. This is especially true for Oxygen gas cylinders. Teflon tape can be used on the outlet side of the regulator, but not on the primary fitting connection between the regulator and the cylinder.
- Never use a cylinder without an attached regulator.
- Add flashback arrestors to oxygen and hydrogen cylinders when used for torches for glass blowing or glass working. Flashback occurs when flames actually traverse through the gas line back to the cylinder outlet.
- Do not completely empty a cylinder before returning it to the loading dock area. Slight positive pressure (between 5 and 15 psi) will keep atmospheric oxygen from contaminating the cylinder contents, so that the cylinder can be safely refilled by the gas cylinder supplier.
- Do not over-tighten a hand-valve on a gas cylinder. If hand tightening will not completely close the valve, call the gas cylinder company for removal.

FLAMMABLE GASSES

- Flammable gasses must be stored in well-ventilated areas away from flammable liquids, combustible materials, oxidizers, open flames, sparks and other sources of heat or ignition.
- Portable fire extinguishers (carbon dioxide or dry chemical type) must be available for fire emergencies where flammable gas is stored.
- Spark-proof tools should be used when working with flammable gas cylinders.
- In the event of an emergency involving a flammable gas, such as a gas leak, fire or explosion, personnel must immediately evacuate the area. Do not attempt to extinguish burning gas if the flow of product cannot be shut off immediately and without risk.
- All lines and equipment associated with flammable gas systems must be grounded and bonded.
- Acetylene should not be utilized in lines or hoses at a pressure exceeding 15 psi.

ASPHYXIANT GASSES

- Do not store asphyxiant gasses in areas without ventilation. This includes environmental chambers (e.g. cold boxes) that do not have a fresh air supply or exhaust system.
- Any gas that has the potential to displace oxygen in sufficient quantities can cause asphyxiation. Only EHS should respond to an inert gas leak or enter an area where an asphyxiant gas could be present. Shut off the source of the gas leak if there is no risk to personnel and ventilate the area. If a person has symptoms of asphyxiation, move the victim to fresh air and call x5911 for medical assistance.

OXIDIZING GASSES

- All equipment used for oxidizing gasses must be free from oils, greases, and other contaminants (hydrocarbons and neoprene are not oxygen-compatible; PTFE Teflon is compatible).
- Do not handle cylinders with oily hands or gloves.
- Oxidizers shall be stored separately from flammable gas containers or combustible materials by a distance of 20 feet.

CORROSIVE GASSES

- Keep exposure to gas as low as possible. Use in fume hood or other vented enclosure when possible. Avoid contact with skin and eyes.
- Wear safety goggles when handling corrosive compressed gasses.

TOXIC AND HIGHLY TOXIC GAS

- Lecture bottle-sized cylinders for all gasses that are toxic must be kept in a fume hood or other continuously mechanically ventilated enclosure. Larger cylinders of toxic or highly toxic gas must be stored in gas cabinets, exhausted enclosures or gas rooms.
- Toxic and highly toxic gasses shall not be stored or used outside of academic or research laboratories.
- Keep exposure to gas as low as possible. Use in fume hood or other vented enclosure when possible. Avoid contact with skin and eyes.
- Wear safety goggles when handling toxic compressed gasses.
- A gas detection system with visible and audible alarms to detect the presence of leaks, etc. must be installed for all toxic and highly toxic gasses when the physiological warning properties for the gas are at a level below the accepted permissible exposure limit or ceiling limit for the gas. Contact EH&S for specifics on installing the gas monitoring system.

CRYOGENIC FLUIDS

- Wear a face shield and chemical safety goggles when dispensing from cylinder or dewar .
- Wear appropriate insulated gloves to protect from the extreme cold when handling cryogenic containers. Gloves need to be loose fitting so that they can be readily removed in the event liquid is splashed into them. Never allow an unprotected part of the body to touch uninsulated pipes or containers of cryogenic material.
- Keep liquid oxygen containers, piping, and equipment clean and free of grease, oil, and organic materials.
- Do not store cylinders or dewars in areas that do not have fresh air ventilation. A leak or venting from the container could cause an oxygen deficient atmosphere.
- First aid treatment for cold-contact burns:
  - Remove any clothing not frozen to the skin that may restrict circulation to the frozen area. Do not rub frozen parts, as tissue damage may result. Obtain medical assistance as soon as possible.
  - Place the affected part of the body in a warm water bath (not to exceed 40° C). Never use dry heat.

PYROPHORIC GAS

- Lecture bottle-sized cylinders for Pyrophoric (e.g. Silane) gasses must be kept in a fume hood or other continuously mechanically ventilated enclosure.
- Silane gas with a concentration of 2% or more by volume silane has additional safety requirements for flow control, exhausted enclosures or gas cabinets and emergency power. Contact EHS for information.

Special Handling Procedures and Storage Requirements

- Handle gas cylinders with extreme care. They are under a great deal of pressure and would transform themselves into fairly powerful missiles if the valve stem on top were to be sheared off. This could happen if they were dropped, especially if the valve stem falls against something on the way down. This will only be prevented if you keep the valve cap on when moving the cylinder.
- Do not store with incompatible material.
- By Fire Code, cylinders must always be secured either by chain or strap to a wall or laboratory bench.
- Keep lecture bottles in ventilated lower hood cabinets when not in use.
- Store flammable gasses at least 20 feet away from oxidizers and corrosives.
- When cylinders are no longer in use, take off their regulators, cap them with valve caps, and return them to storage. Do not allow unused cylinders to accumulate in your laboratory.

WASTE DISPOSAL

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- Excess and empty COMPRESSED GASSES should be returned to the manufacturer.
- Do not dispose of compressed gas cylinders, even if empty, as residual pressure and product will remain.
- Contact EHS at x3427 for hazardous waste removal.

Emergency Numbers

Emergency Numbers:

Fire and Medical Emergencies	x5911 (911 on cell phone)
Environmental Health and Safety	x3427
FastMed Urgent Care (employees)	(336) 714-4616
Student Health (students only)	x5218
Poison Control	800-222-1222

First Aid

1. If inhaled: If breathed in, move person into fresh air. If not breathing, give artificial respiration. Call x5911 for medical assistance.
2. Treat exposure symptomatically.

Spill and Accident Procedure

➢ In the event of a leak or suspected leak of gas, evacuate the area and contact the Lab Manager and x3427.